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**TANNER AND KING CRABS
IN THE COOK INLET MANAGEMENT AREA
Stock Status and Harvest Strategies**

A Report to the Alaska Board of Fisheries

By

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and

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ABSTRACT

The Alaska Department of Fish and Game (ADF&G) manages commercial fishing for Tanner *Chionoecetes bairdi* and red king *Paralithodes camtschatica* crab stocks in the Cook Inlet Management Area. The management area is divided into six districts. The Southern, Kamishak, and Barren Islands Districts have historically supported the largest commercial fisheries whereas the Outer, Eastern, and Central Districts have supported smaller fisheries. Management of these resources was originally based solely on fisheries performance. From the 1970's to 1990, pot surveys were used to index crab abundance in the Southern, Kamishak, and Barren Island Districts. Trawl surveys have been used annually since 1990 to estimate absolute abundance of Tanner crab and relative abundance of red king crab. Tanner crab stocks in all surveyed districts have been at low abundance levels since the early 1990's, and no commercial harvests will be allowed until abundance increases. Red king crab stocks have been at extremely low abundance levels in all surveyed districts since the mid-1980's, and no commercial, recreational or subsistence harvests will be allowed until stocks recover. To meet an existing regulatory mandate, and to prepare for a future commercial Tanner crab fishery, we have developed harvest strategies for Tanner crab in the primary harvest districts of the Cook Inlet Management Area. Strategies include harvest rates that vary in relation to stock abundance estimates. In addition, we propose stock abundance thresholds below which fisheries would remain closed. A plan for king crab should be developed in the future.

INTRODUCTION

The Cook Inlet Management Area supported commercial harvests of Tanner crab *Chionoecetes bairdi* since at least the 1960's and red king crab *Paralithodes camtschatica* since at least 1937. The Alaska Department of Fish and Game (ADF&G) has management authority for these crab resources, and has divided the management area into six districts. The Southern, Kamishak, and Barren Islands Districts have historically supported the largest commercial fisheries whereas the Outer, Eastern, and Central Districts have supported smaller fisheries. Most crab stocks in Alaska have experienced large fluctuations in population abundance (Kruse 1993), and harvests from these resources must be adjusted in relation to the level of population abundance. Tanner crab stocks in all surveyed districts of Cook Inlet have been at low abundance levels since the early-1990's and no commercial harvests will be allowed until abundance increases. Red king crab stocks have been at extremely low abundance levels in all surveyed districts of Cook Inlet since the mid-1980's, and no commercial, recreational or subsistence harvests will be allowed until stocks recover-. Despite the absence of fisheries, ADF&G has maintained its program of annual surveys to monitor changes in abundance of Tanner and king crabs. Due to changes in assessment techniques, it is important to periodically review and evaluate management strategies for these crab species in the Cook Inlet area. The objectives of this report are to 1) summarize harvest and survey data on Tanner and king crabs in the Cook Inlet Management Area, 2) describe existing regulations, and 3) recommend management plans for Tanner crab in the primary fishing districts of the management area. Specific management recommendations for Tanner crab include harvest rates which vary in relation to stock abundance estimates, stock abundance thresholds below which fisheries remain closed, and measures such as preseason vessel registration to ensure the fishery can be managed for a guideline harvest level (GHL). A plan for king crab should be developed in the future.

Harvest data reported for the Cook Inlet Management area were compiled from historical annual management reports, previous reports to the Alaska Board of Fisheries, and data summaries from the ADF&G fish ticket harvest database. Survey data were compiled from historical survey reports and annual management reports.

MANAGEMENT AREA

The Cook Inlet Management Area, Statistical Area H, includes all waters west of Cape Fairfield (148° 50' W long.) and north of Cape Douglas (58° 51' N lat.) The management area is divided into six shellfish districts: Southern, Kamishak, Barren Islands, Outer, Eastern, and Central (Figure 1). For king and Tanner crab management, the Kamishak and Barren Island Districts have typically been managed as a single unit and the Outer and Eastern Districts have similarly been managed as a single unit; that is, they have opened and closed concurrently.

GENERAL MANAGEMENT APPROACHES

Harvest strategies have changed greatly during the last two decades as assessment tools have improved and computer technology has allowed more comprehensive assessment models to be generated. Kruse (1993) describes four harvest strategies that have been applied to Alaskan crab stocks. The first strategy, fishery performance management, is based on a guideline harvest level (GHL) or range (GHR) determined from past fishery catches or catch-per-unit-of-effort (CPUE) data. This strategy assumes fishery catches over a specific time period are proportional to resource abundance. As the fishery takes place, the GHL or GHR may be adjusted if observed catches or CPUE rates differ substantially from preseason expectations. Because fishery performance management lacks independent estimates of resource abundance, changes in harvest efficiency as well as crab behavior (e.g. availability, accessibility, and vulnerability) can greatly alter relationships between catch or CPUE and resource abundance. A second strategy, size, sex, and season (3-S) management, is based on minimum size limits, sex restrictions, and closed seasons during mating and molting. A third strategy, size and sex (2-S) management, is based only on minimum size limits and sex restrictions. A fourth strategy, exploitation rate management, is based on use of a preseason GHL or GHR that is the product of a desired exploitation rate and an estimate of the exploitable biomass. Most crab fisheries off Alaska are currently managed using a combination of these strategies.

Trawls have been used to conduct crab assessment surveys in the Cook Inlet Management Area since 1990. Prior to that year, all surveys were done using pots to provide an index of crab population abundance (Davis 1981; Kimker 1991*b*). Surveys with pots attempted to closely replicate the gear and techniques used by the commercial fishing fleet, and, when combined with tagging, could be used to generate population estimates. However, use of trawls has several advantages over use of pots for assessment surveys. First, the area sampled by a trawl can be defined, which allows absolute abundance to be estimated for the sampled population (Gunderson 1993). For pot gear, the effective sampling area is difficult to define and subject to great variability due to factors such as water currents and the type and quantity of bait used. Second, trawl gear is generally less selective for particular sizes of crab, although pot gear may be modified, such as by closure of any escape rings, to improve retention of small crab. Third, pots can become "saturated" when densities of captured crab become high enough to change fishing effectiveness over time. Although trawl saturation can occur, tow duration can be reduced to maintain catches with a known sampling area. Because of these characteristics, pot surveys provide only a relative measure, or index, of abundance, while trawl surveys can provide actual population estimates. Particular care must be taken in designing surveys using either gear to avoid overestimating crab abundance and setting rates that are not sustainable.

The phenomenon of Tanner crab skip-molting, the failure to molt and grow into a larger size class, confounds assumptions about growth to maturity. This makes it difficult to set a legal size because crab should have had at least one opportunity to mate before they enter the fishery (Kruse 1993). In addition, studies show larger crab tend to have more reproductive success, which makes the presence of larger crab important to overall population structure and production (Adams 1985; Paul and Paul 1990). Stock management has historically been based on estimated productivity, so skip-

molting complicates management and fishery recruitment expectations. This is particularly true for prerecruit-2 through recruit size classes, which are often used as an important indicator of stock status and to predict future harvests. In some areas, skip molting rates are so high that most prerecruit-1 crabs never achieve legal size.

Board of Fisheries Proposals

Management strategies for crab resources have developed over time in response to improvements in assessment techniques, knowledge of crab biology in different geographic areas, and efficiency and effectiveness of the fishing fleet. Several proposals to modify management strategies for Tanner and king crabs have been submitted for consideration during the 1998-1999 meeting cycle of the Alaska Board of Fisheries (Appendix A). Of particular note is Proposal 344, which would seek to bring management regulations for Tanner crab in the Cook Inlet Management Area into compliance with Regulation 5AAC 35.080 through establishment of a Tanner crab harvest strategy.

Basis for Tanner Crab Management Plans

Management of Tanner crab in the Cook Inlet Management Area was historically based on fisheries performance, using catch-per-unit-of-effort (CPUE) as an index of stock abundance. The initial management approach only allowed males to be harvested. As the fisheries developed, fishing pressure intensified and gear efficiency improved. This led to adoption of regulations to improve fishery manageability and provide for stock conservation. Seasonal closures were first implemented in 1973, and minimum size regulations were established in 1976. Beginning in 1987, the fishing season was changed so that it no longer overlapped two calendar years; the season opened by regulation on January 15 and closed by emergency order. Several additional regulations that have been adopted for all Tanner crab fisheries in the Cook Inlet Management Area include:

- 1) Superexclusive vessel registration;
- 2) Vessel registration prior to the season opening;
- 3) Gear storage for 30 days before and 30 days after a season in waters 15 fathoms or less;
- 4) A 75-pot limit per vessel;
- 5) Buoy identification tags to assist with pot limit enforcement;
- 6) A minimum of four 4 3/4 inch escape rings on all pots;
- 7) A season opening date of January 15;
- 8) Retention of only male Tanner crab with a carapace width of 5 1/2 inches (140 mm) or larger;
- and
- 9) Biodegradable escape mechanisms on crab pots.

Subsequent to the establishment of most existing regulations, assessment techniques have changed for Tanner and king crabs off Alaska. The most important change for the Cook Inlet Management Area has been the use of trawl gear to estimate absolute abundance. Concurrent trawl and pot

surveys were conducted in only one year, 1990. Although additional analysis of historical data is being conducted, a preliminary review failed to show a direct correlation between trawl and pot survey data sets based solely on the 1990 survey year. Thus, it is difficult to develop a time series of absolute population abundance estimates using pot survey data. However, models that track cohort strength based on annual changes in crab size composition have had some success estimating past and present population abundance (Zheng et al. 1998).

The Policy on King and Tanner Crab Resource Management Goal and Benefits, adopted through regulatory reference under 5AAC 34.080 for king crab and 5 AAC 35.080 for Tanner crab, describes elements to consider in management of Tanner and king crabs. These regulations also require that current harvest strategies not be changed without being reviewed by the Board of Fisheries process prior to allowing fishing. In addition to state regulations, federal regulatory requirements must be followed because the department was delegated management authority for the Tanner and king crab resources in federal waters of the Gulf of Alaska.

Adoption of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), particularly national standard 1 guidelines (50 CFR 600.310), produced several changes in management practices for marine resources (NPFMC 1998). Under MSFCMA, maximum sustainable yield (MSY) is defined as the largest long-term average harvest that can be taken from a stock or stock complex under prevailing ecological or environmental conditions.

MSY stock size (B_{msy}) is defined as the long term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate units, that produces MSY. In the absence of a comprehensive time series of biomass estimates, proxy estimates of MSY and B_{msy} may be used. Additionally, a minimum stock size threshold (MSST), below which no fishing would occur, is defined as the greater of either one half B_{msy} or the minimum stock size at which rebuilding to B_{msy} would be expected to occur within 10 years if the stock were exploited at the maximum fishing mortality threshold (F_{msy}). Lacking other information to estimate F_{msy} , it is generally assumed to equal the instantaneous natural mortality rate (M).

The Environmental Assessment for Amendment 7 to the Fishery Management Plan for commercial king and Tanner crab fisheries in the Bering Sea/Aleutian Islands Management Area defines three tiers of data for development of management standards (NMFS 1998). Cook Inlet Tanner crab data fit under Tier 2 is used for stocks having limited or inconsistent survey data but moderately comprehensive harvest data. Alternative 2 under Tier 2 allows MSY to be estimated from a proxy of the mature biomass and the stock utilization rate.

In the case of Cook Inlet Tanner crab, a proxy of mature biomass was calculated using historical abundance data for legal male crab. For the years following development of the commercial fishery and prior to the trawl surveys, population abundance of legal males was estimated from mean annual harvest abundance adjusted (divided) by the assumed exploitation rate. Exploitation rates of Tanner crab in the Cook Inlet Management Area are unknown prior to 1990. Historically, many Tanner crab fisheries in Alaska were managed for a 40% harvest rate (Zheng and Kruse 1999). Given the history of the Cook Inlet fisheries, it is reasonable to assume that Tanner crab exploitation was at least 40% of the legal male population. Thus, annual commercial harvest abundance data from the year when the fishery was developed through the most recent fishery year prior to 1990,

were divided by the assumed 40% exploitation rate to give an estimate of the annual underlying population.

Population estimates for the years 1990-1998 were obtained from trawl survey data (Bechtol 1998). B_{msy} was then calculated as mean annual abundance of legal male crab from the time the fishery was developed to the present. This approach encompassed the wide range of variability exhibited by the stock. Recent years of low abundance are included, as are the years of very large harvests in the 1970's, in order to provide an average representation of the population and average yield from that population. Although a sustainable yield approach should be the largest long-term average catch that can be expected, it is reasonable to include both high and low population years so that the estimated of B_{msy} is not skewed by either historically high or low population levels. The use of historical harvest abundance data, adjusted by the exploitation rate, and combined with trawl survey data, results in a mean legal male abundance that is based on average population performance over the longest possible time series. This makes the best use of all available data.

Kruse (1993) suggested F_{msy} for Tanner crabs in Alaska be set at 0.3, which corresponds to an annual exploitation rate of 26%. However, this exploitation rate, assumed to equal average natural mortality, may be excessive under some environmental conditions or for particular stocks. Of special concern are populations which are declining in abundance, since spawning stock biomass may be driven to levels insufficient to provide adequate and consistent recruitment (referred to as recruitment overfishing; Gulland 1983). Thus, following a precautionary approach (e.g., United Nations 1994; Caddy 1995), it is appropriate to reduce the exploitation rate as population abundance declines. Given the harvest history and collapse of Cook Inlet Tanner crab populations, it is also prudent to keep instantaneous fishing mortality below estimated F_{msy} even when stocks are estimated to have reached or exceeded B_{MSY} . The department recommends maximum instantaneous fishing mortality for the commercial fishery not to be allowed to exceed 0.22, which corresponds to an annual exploitation rate of 20%. Although harvest rates as high as 50% have been suggested for Tanner crab in the Eastern Bering Sea, the history of Cook Inlet stocks suggests a much more precautionary approach is appropriate (Zheng and Kruse 1999). In addition, personal use, sport, and subsistence harvests are not specifically included in the proposed management plans but are accommodated through a conservative management approach. Cook Inlet Tanner crab stocks would, therefore, be managed for an optimum yield rather than maximum yield.

TANNER CRAB

Southern District

Harvests

The Southern District Tanner crab fishery occurs in the relatively protected waters of Kachemak Bay. Both small (< 50 ft keel length) and large vessels participate; approximately 50 percent of the vessels do not have circulating crab tanks. Homer and Seldovia, home ports to most of the fleet, are

less than 3-hours travel from the geographic extremes of the district. Fishing depths range from 5 to 95 fathoms, but generally are between 30 and 65 fathoms. The commercial Tanner crab fishery began in the mid-1960s when this species was harvested incidentally to red king crab (Davis 1981). Greater fishing effort was directed toward Tanner crab during the 1970's when price and demand increased. The first large harvest of Tanner crab was 1.4 million lb from the Southern District in the 1968-1969 season (Table 1). Fishing effort quickly expanded to other Cook Inlet districts, and a peak harvest of 8.0 million lb from all districts in the management area was reached during the 1973-1974 season (Figure 2). Southern District catches cycled at approximately six-to-seven year intervals with large harvests of 2.9 million lb in 1972-1973, 2.8 million lb in 1977-1978, 1.2 million lb in 1984-1985, and 0.5 million lb in 1993 (Kimker 1996). Mean Southern District harvest was 1.2 million lb during 1968 to 1994. Effort ranged from 35 vessels in 1976-1977 to 136 vessels in 1993. Commercial fishing for Tanner crab in the Southern District was closed in the 1989 and 1990 seasons, and has remained closed since 1995 due to depressed stock levels. The Southern District produced the largest crabs in the management area with mean weight ranging from 2.30 lb in 1985-1986 to 2.85 lb in 1974-1975 (Table 2).

Regulations for the commercial harvest of Tanner crab in the Southern District are generally consistent with other Cook Inlet Area regulations. One exception is a cold weather provision. Research by the National Marine Fisheries Service indicated increased mortality and reduced molt probability in Tanner crab temporarily exposed to extreme cold weather conditions (Carls and O'Clair 1990). Therefore, regulations were adopted that allowed the department to suspend or delay the Southern District fishery during weather conditions which are likely to increase crab discard mortality. Weather conditions under which the department has conducted a fishery have been a minimum air temperature of 15°F and a maximum wind speed of 10 mph.

Two other regulations distinctive to the Southern District commercial Tanner crab fishery are:

- 1) Gear storage in the eastern portion is restricted to water depths of 10 fathoms or less; and
- 2) A limit of 40 pots per vessel is imposed, if the Southern District GHL is less than 800,000 lb.

Sport and Personal Use Harvests.

The Cook Inlet area supports sport and personal use Tanner crab fisheries, particularly within Kachemak Bay (Figure 1). Mean annual harvest from 1981 to 1997 was 5,409 crab (13,523 lb) in the sport and personal use fisheries of the Southern District (Nicky Szarzi, Alaska Department of Fish and Game, Homer, Alaska, personal communication). Annual harvests ranged from 10,936 Tanner crab (27,340 lb) in 1995 to 1,142 crab (2,855 lb) in 1991 (Table 3). Since 1996, participants have been required to obtain a shellfish permit prior to sport and personal use fishing for Tanner crab in waters of Kachemak Bay east of a line from Anchor Point to Point Pogibshi. Permits are available from department offices and fishing license vendors. Area-wide season dates are July 15 through March 15. In Kachemak Bay, the season occurs from July 15 through December 31 and then from either January 15 or the opening of a commercial Tanner crab fishery to March 15. There is a four pot limit per vessel and each pot must have two escape rings $4\frac{3}{8}$ inches in diameter. Daily

bag and possession limits are 20 male crab and the minimum legal size of 5½ inches is same as that used for the commercial fishery.

Surveys

Tagging studies with Tanner crab were conducted from 1974 to the mid-1980's (Davis 1981; Kimker et al. 1985). Results indicated that legal male Tanner crab did not migrate between the Southern District and the Kamishak and Barren Islands Districts (Figure 1).

Beginning in 1974 in the Southern District, annual pot surveys were used to develop an index of abundance and set the harvest level for subsequent commercial fisheries (Figure 3; Kimker 1991*b*). Mean catch of legal male Tanner crab in Southern District pot surveys ranged from 39.8 crab per pot in 1977 to 11.4 crab per pot in 1988 (Table 4). Catch rates of sublegal males ranged from 36.5 crab per pot in 1980 to 3.6 crab per pot in 1989. Sublegal male catch rates from 1988 to 1990 were the lowest in the history of the pot survey. Female catch rates also declined steadily from 1987 to 1990. A relatively large survey catch of 24.6 legal males per pot obtained in 1990 is somewhat misleading. Only 60 pot hauls were made in 1990, compared to a minimum of 212 pot hauls in preceding years, and the 1990 survey was conducted only at stations that had historically yielded large numbers of crab (Kimker 1991*b*). Pot surveys were discontinued after 1990.

Trawl surveys have been used annually since 1990 in the Southern District to estimate population abundance of Tanner crab and to provide a relative abundance index for red king crab (Table 5; Figure 3; Kimker 1991*a*; Bechtol 1998). Most individual survey stations encompass 6.3 square nautical miles (maximum of 8.9 square nautical miles), which is the area represented by a typical, single trawl tow (Bechtol 1998). From 18 to 23 stations have been sampled annually, yielding a mean estimate of 1.4 million sublegal male crab and 360,000 legal male crab. Annual abundance of legal male crab has remained substantially below the historical mean since 1994. Legal male crab comprised from 4.1% to 14.5% of the male population, with a mean of 8.9%. Skip molt Tanner crab occur in the Southern District, as evidenced by the abundance of old shell male crab in the trawl survey, but annual incidence of skip molts has been highly variable (Table 5). Although there has been a lack of postrecruit crab in recent years, incidence of prerecruit skip molts in the trawl survey has generally decreased relative to the trawl survey history. Thus, it is unlikely that increases in skip molts account for the continued decline of Tanner crab in the Southern District. Abundance of female Tanner crab has ranged from 1.4 million crab in 1991 to 388,000 crab in 1998, with a mean of 944,000 crab among all years (Table 6). Mature crab comprised an average of 50.6% of the female Tanner crab population among survey years. However, the 1998 survey produced both the lowest total female abundance and the lowest percent mature females (18.2%) in the history of Southern District trawl surveys.

Proposed Management Strategies

Existing regulations should continue to be included as components of the management strategy for Tanner crab in the Southern District. The department also recommends inclusion of the following: 1) a harvest rate scaled relative to population biomass; 2) a minimum stock size

threshold (MSST); and 3) establishment of a time-certain registration deadline so that fishing potential can be evaluated to ensure fishing pressure does not force the population biomass below MSST.

The Southern District Tanner crab fishery was considered fully developed by the 1968-1969 season, and the last fishery occurred in 1994 (Table 1). A proxy of B_{msy} was calculated as using a combination of historical fishery data and more recent trawl survey data. Annual population abundance of legal male crab during 1968 to 1988 was estimated from harvest abundance adjusted by a 40% exploitation rate. Estimated population abundance was then averaged with annual trawl survey estimates of legal male crab during 1990 to 1998. The long-term average of 1.1 million crab corresponds to a B_{msy} of 2.7 million lb (assuming 2.57 lb/crab). MSST, at one half of B_{msy} , became approximately 0.5 million crab and 1.4 million lb.

Under the proposed harvest strategy (Appendix B), if the estimate of legal males equals or exceeds B_{msy} , the stock may be harvested at an instantaneous fishing mortality of $F=0.22$, or an annual exploitation rate of 20% of the estimated legal males. If the legal male population equals or exceeds MSST but is less than B_{msy} , a fishing mortality of one-half the maximum allowed at MSY is recommended. This corresponds to an F of 0.11, or an annual exploitation rate of 10% of the estimated legal males. When the estimated legal male Tanner crab population is less than 90% of MSST, no commercial harvest will be allowed. The use 90% of MSST as a benchmark is intended to prevent the fishery from driving the population below MSST and would be particularly important in the initial years after a stock has recovered from being below MSST.

Under this scenario, the Southern District would not have opened to commercial Tanner crab fishing in 1990, 1991 or 1994. Although the trawl survey estimate of legal males exceeded MSST in 1993, we would not have opened the fishery, because a 10% harvest rate would have forced the population below MSST.

Kamishak and Barren Islands Districts

Harvests

The Kamishak Bay and Barren Islands Districts are managed as a single unit for Tanner crab because survey, fishery, and tag recovery information indicate these two districts contain a single stock of Tanner crabs (Davis 1981). The fishery in the Kamishak and Barren Islands Districts occurs in open waters subject to severe weather and icing conditions, as well as extreme tides and seasonal ice flows from upper Cook Inlet and Kamishak Bay. Safe anchorage from storms is located behind Augustine Island or within Iniskin Bay. Most participating vessels have circulating sea water systems. The smallest vessels are generally less than 50 ft in keel length. Fishing by these smaller vessels is often limited by poor weather conditions. Much of the fleet fished around the clock; with boats "jogging" while the gear soaked. Fishing occurred in a 15 to 90 fathom depth range. Historical catch following full development of the fishery and implementation of the legal minimum size has ranged from 0.4 to 3.3 million lb (Table 1; Figure 4). Tanner crab harvests in the Kamishak and Barren Islands Districts ranged from 12,398 lb in 1968-1969 to 4.7 million lb in

1973-1974. The fishery was closed in 1989, and 1992 through 1999 due to depressed stock conditions. Vessel effort ranged from 7 to 28 boats (Table 1). The Kamishak and Barren Islands Districts had the smallest crabs from sampled districts, with annual mean weights of 2.09 to 2.35 lb (Table 2).

Existing management regulations for Tanner crab in the Kamishak and Barren Islands Districts are generally consistent with management measures in other portions of the Cook Inlet Management Area. Cold weather regulations for the Southern District were not adopted for the Kamishak and Barren Islands Districts because transit time from port complicates short-term, inseason fishery changes, and comparatively low effort results in more selective gear placement and less crab handling during a season.

Surveys

Tagging studies with Tanner crab were conducted in the Kamishak and Barren Islands Districts from 1975 to the mid-1980's (Davis 1981; Kimker et al. 1985). Results indicated that legal male Tanner crab in these districts comprised a single stock, but that legal male Tanner crab did not migrate between the Southern District and the Kamishak and Barren Islands Districts. Furthermore, legal males tagged in these two districts were recaptured in Kodiak's North Mainland Section, but only on a regular basis as far south as Douglas Reef immediately south of Cape Douglas (Figure 1). Due to the latter finding, survey results from the Kamishak and Barren Islands Districts are often compared to results from surveys conducted immediately south of Cape Douglas by Kodiak ADF&G staff. Based on the tagging studies, it is likely that Tanner crab found north and south of Cape Douglas will exhibit similar changes in stock abundance.

Beginning in 1975 in the Kamishak and Barren Island Districts, annual pot surveys were used to develop an index of abundance and set the harvest level for subsequent commercial fisheries (Figure 4; Kimker 1991b). Mean catch of legal male Tanner crab in pot surveys ranged from 27.8 crab per pot in 1975 to 1.9 crab per pot in 1983 and 1987 (Table 7). Mean catch among all survey years was 8.0 legal male crab per pot, although annual catch rates exceeded this mean in only five survey years, all of which were prior to 1981. Catch rates of sublegal males ranged from 62.2 crab per pot in 1978 to 13.1 crab per pot in 1984. Pot surveys were discontinued after 1990 (Kimker 1991a).

Trawl surveys have been used annually since 1990 in the Kamishak and Barren Islands Districts to estimate abundance of Tanner crab and provide a relative abundance index of red king crab (Table 5; Kimker 1991a; Bechtol 1998). Most individual survey stations encompass 26.1 square nautical miles (maximum of 39.0 square nautical miles); this is the area represented by a typical, single trawl tow (Bechtol 1998). The annual sampling effort of 16 to 28 stations resulted in a mean abundance estimate of 3.0 million sublegal and 293,000 legal male crab among all survey years. Annual abundance of legal male crab has ranged from 594,000 in 1990 to 111,000 in 1993. Few postrecruit crab have been captured by trawl surveys in these districts. Male skip molt crab, indicated by the old-shell component, are much more prevalent in the Kamishak and Barren Island Districts than in other portions of the Cook Inlet Management Area (Table 5). For example, old-shell crab comprised an average of 73% (range of 42% to 91%) of the prerecruit-1 size class during the trawl survey time series. Because old-shell crab are assumed to be in terminal molt, these crab are not

likely to grow to a larger size class and will never achieve a legal size for harvest. In addition, an average of 76% of the recruit size class were old-shell crab. The implications of skip-molting are not well understood, but a predominance of crab in this condition is likely to hinder recovery of the Kamishak and Barren Island Tanner crab stock. Estimated abundance of female Tanner crab in the Kamishak and Barren Islands Districts has ranged from 2.6 million in 1990 to 305,000 in 1998 (Table 6). The estimated abundance of 7,900 mature female crab in 1998 represented a substantial decrease from historical levels.

Proposed Management Strategies

Existing regulations should continue to be included as components of the management strategy for Tanner crab in the Kamishak and Barren Islands Districts. The department also recommends inclusion of the following: 1) a harvest rate scaled relative to population biomass; 2) a minimum stock size threshold (MSST); and 3) establishment of a time-certain registration deadline so that fishing potential can be evaluated to ensure fishing pressure does not force the population biomass below MSST.

The Kamishak and Barren Islands Districts Tanner crab fishery was fully developed by the 1970-1971 season and the last fishery occurred in 1991 (Table 1). A proxy for B_{msy} was calculated as using a combination of historical fishery data and more recent trawl survey data. Annual population abundance of legal male crab during 1970 to 1988 was estimated from harvest abundance adjusted by a 40% exploitation rate. Estimated population abundance was then averaged with annual trawl survey estimates of legal male crab during 1990 to 1998. The long-term average of 1.6 million crab corresponds to a B_{msy} of 3.5 million lb (assuming 2.24 lb/crab). MSST, at one half of B_{msy} , became approximately 0.8 million crab and 1.7 million lb.

Under the proposed harvest strategy (Appendix C), if the estimate of legal males equals or exceeds B_{msy} , the stock may be harvested at an instantaneous fishing mortality of $F=0.22$, or an annual exploitation rate of 20% of the estimated legal males. If the legal male population equals or exceeds MSST but is less than B_{msy} , a fishing mortality of one-half the maximum allowed at MSY is recommended. This corresponds to an F of 0.11, or an annual exploitation rate of 10% of the estimated legal males. When the estimated legal male Tanner crab population is less than 90% of MSST, no commercial harvest will be allowed. The use 90% of MSST as a benchmark is intended to prevent the fishery from driving the population below MSST and would be particularly important in the initial years after a stock has recovered from being below MSST.

Under this scenario, the Kamishak and Barren Islands Districts would not have opened to commercial Tanner crab fishing in 1990 or 1991.

Other Districts

Harvests

The Outer and Eastern Districts are located in the Gulf of Alaska and border the Prince William Sound Management Area on the east at Cape Fairfield. The exposed open waters in the Gulf of Alaska portion of these districts provided significant portions of the catch in the developmental years of the fishery. More recently the fishery occurred in or near the mouths of the bays along the outer Kenai Peninsula coast. The fleet in these districts is composed of both small and large vessels. Smaller boats typically fished in bays where greater protection is available during poor weather. Most vessels delivered to Seward, although some delivered to Homer.

Catches of Tanner crab catches from the Outer and Eastern Districts peaked at 1.9 million lb in the 1973-1974 season. Catches subsequently decreased from 824,000 to 53,000 lb following implementation of a minimum legal size in 1976. The fishery was closed by emergency order from 1989 through 1991, and has remained closed from 1993 to the present due to depressed stock conditions. Participation ranged from 7 to 25 boats (Table 1). Although little data are available, mean crab weight appears to be slightly smaller in the Outer and Eastern Districts than in other districts (Table 2).

Tanner crab harvests were reported from the Central District only in 1988 and 1989. In both years the catch was less than 10,000 lb.

Existing management regulations for Tanner crab in the Outer, Eastern, and Central Districts are generally consistent with management measures in other portions of the Cook Inlet Management Area.

Surveys

Little fishery-independent data exists for Tanner crab resources in the Outer, Eastern, and Central Districts. Fishery performance data indicates these stocks have declined in concert with Tanner crab resources along the northern and western coasts of the Gulf of Alaska. In addition, the smaller mean crab weight recorded for these districts crab resources in the Management area may indicate a lack of large, postrecruit crab (Table 2).

Proposed Management Strategies

Tanner crab stocks in the Outer, Eastern, and Central Districts are not anticipated to recover to an extent that would support directed fishing in the near future. The department has proposed a regulatory closure of Tanner crab fishing in these districts. When stocks throughout the management area have shown substantial recovery, the department will approach the board with management plans.

KING CRAB

Both red king crab and brown king crab *Lithodes aequispina* occur in the Cook Inlet Management Area (H), although brown king crab have only been caught infrequently in the outer portion of the management area in the Gulf of Alaska. Most of the red king crab harvest occurred in the Southern, Kamishak, and Barren Islands Districts (Table 8; Figure 1). Very small harvests occurred in the Outer District and no harvests were reported from the Eastern District.

Similar to the Tanner crab fishery, regulations for king crab fishery were developed along with the fishery. Most regulations are consistent among all king crab fisheries in the Cook Inlet Area and include:

- 1) Superexclusive vessel registration;
- 2) Vessel registration prior to the season opening;
- 3) Gear storage for 30 days before and 30 days after a season in waters 15 fathoms or less;
- 4) A 75-pot limit, except a 40-pot limit is in effect if the GHL is less than 1.5 million lb.
- 5) Buoy identification tags to assist with the pot limit enforcement;
- 6) Season dates of August 1 through March 15;
- 7) Retention of only male king crab with a minimum carapace width of 7.0 inches (178 mm) may be retained, except a season with a minimum carapace width of 8.0 inches (203 mm) may be established by emergency order;
- 8) Retention of male brown king crab only under terms of a commissioner's permit.

Historically, the commercial season opened on August 1. The season opening date was changed to July 15 during 1983 to 1987, and then was moved back to August 1 in 1988. The minimum legal size of 7.0 in (178 mm) carapace width was established for all species of king crabs in 1963. The provision allowing an 8.0 in (203 mm) season to be opened and closed by emergency order was adopted in 1976.

Southern District

Harvests and Management Strategies

The earliest recorded commercial landings of king crab occurred in 1937 when crabs were canned at a Halibut Cove facility (Kimker 1996). The proximity to port and processors enabled daily fishing trips. Through the 1940's, commercial fishing for this species remained at relatively low levels and occurred primarily in the Southern District. By the mid-1950's, annual harvests increased to approximately 2.0 million lb. Harvests peaked at 2.8 million lb in the 1962- 63 season and reached a low of 0.18 million lb during 1981-82, the last year of commercial harvest. The fishery has subsequently remained closed by emergency order due to

low abundance (Table 8). The fishery was historically managed for a GHR based upon pot survey indices.

Sport and Personal Use Harvests

An estimated 6,180 king crab were harvested by sport and personal use fisheries in 1981. Harvests declined to a low of 62 crab in 1984. Sport and personal use fisheries for king crab have remained closed since 1985.

Surveys

Annual pot surveys were conducted in the Southern District from 1974 until 1990 to develop annual abundance indices used to set the commercial harvest levels for the subsequent fisheries (Kimker 1991*b*). Catch rates of legal male king crab in the Southern District ranged from 0.4 crab per pot in 1982 to 5.3 crab per pot in 1980 (Table 9). A mean catch of 4.8 crab per pot in the 1990 survey is somewhat misleading. Most crab were caught at a single survey station and the 68-pot sampling effort, substantially less than previous surveys, focused on stations that historically exhibited the largest concentrations of king crab. Mean catch among all years was 7.7 sublegal and 1.8 legal king crab. Catches of female king crab also declined from 46.4 crab per pot in 1977 to 0.1 crab per pot in 1990. Mean catch among all years was 9.7 females per pot.

Trawl surveys have been conducted annually in the Southern District since 1990 (Kimker 1991*a*; Bechtol 1998). Red king crab are not abundant and have a patchy distribution, as is evidenced by the variability in trawl survey catches (Table 10). Population abundance estimates have not been calculated and survey results are treated as an index of king crab abundance. Total survey catches of male red king crab have ranged from 105 in 1991 to 0 in 1998. Mean catch among survey years was 21.9 crab per survey, although annual catches have not achieved this average since 1992. Most king crabs captured during the trawl surveys have been of legal size. The Southern District red king crab population remains severely depressed and all crab are needed to sustain the limited existing productivity. Because a stock recovery is not anticipated in the near term, a regulatory closure of all king crab fisheries in the Cook Inlet management Area is requested, and the stock will continue to be monitored through trawl surveys. When recovery of the population is evident, a management plan will be developed for consideration by the board and user groups. At that time, the department will evaluate a variety of survey options to determine the best alternatives relative to available assessment tools.

Kamishak and Barren Islands Districts

Harvests and Management Strategies

During the 1960's the king crab fishery expanded to the Kamishak Bay and Barren Islands Districts. Harvests peaked at 5.5 million pounds in the 1962-1963 season. However, catch dropped significantly the following year after processing facilities in the Seldovia area were

severely damaged by the 1964 earthquake. Catches ranged from 1.4 to 3.0 million lb for the next decade before drastically declining in the early 1980's. The commercial fishery has remained closed due to low stock abundance following a harvest of only 188,000 lb in the 1983-84 season.

King crab fishery regulations are consistent with other districts in the management area. The minimum legal size was increased to an 8.0-inch carapace width for the 1976-77 and 1977-78 seasons. However, research on the reproductive capabilities of male king crabs now indicates that large males are more important to the brood stock than small males (Paul and Paul 1990). Therefore, there will be no further effort to justify an 8.0 in king crab season as provided for by regulation.

Survey and Stock Status

Annual pot surveys were conducted in the Kamishak and Barren Islands Districts from 1975 until 1990 to develop an index of abundance and set the harvest level for subsequent commercial fisheries (Kimker 1991*b*). Catches of legal male king crab in the ranged from 0.3 crab per pot in 1986 to 27.0 crab per pot in 1975 (Table 11). The 1975 catch per pot was much greater than the catch obtained in any other survey year. Mean catch among years was 4.6 legal male crab per pot. Catch rates for female king crab also declined from 37.6 crab per pot in 1977 to 1.0 crab per pot in 1988. Mean catch among all years was 10.0 females per pot.

Trawl surveys have been conducted annually in the Kamishak and Barren Islands Districts since 1990 (Kimker 1991*a*; Bechtol 1998). Red king crab are not abundant and have a patchy distribution in trawl survey catches (Table 10). Population abundance estimates are not calculated and the survey is treated as an index of king crab abundance. Catches of male crab in annual surveys have ranged from 46 in 1997 to 3 in 1994, with a 1998 catch of 14 crab. Mean catch among survey years was 15.7 crab per survey. Most of the catch in recent years has been comprised of sublegal king crab, although more legal size crab were caught in the early 1990's. The king crab population in the Kamishak Bay and Barren Islands Districts remains severely depressed; all crab are needed to sustain the limited existing productivity. Because a stock recovery is not anticipated in the near term, a regulatory closure of all fisheries is requested, and the stock will continue to be monitored through trawl surveys. When recovery of the population is evident, a management plan will be developed for consideration by the board and user groups. At that time, the department will evaluate a variety of survey options to determine the best alternatives relative to available assessment tools.

CONCLUSION

Tanner crab stocks remain at low levels of abundance compared to historical harvest levels. The decline in Tanner crab populations is a recent phenomenon, and some stocks still support non-commercial fisheries. In anticipation of future increased abundance of Tanner crab stocks, the department has submitted strategic plans to guide future openings and management of Tanner crab

fisheries in the Cook Inlet Management Area. These plans use the available data from a wide range of historical stock conditions. To monitor stock conditions, the department remains committed to monitoring the status of these resources through fishery-independent surveys.

King crab resources in the Cook Inlet Management Area remain severely depressed despite being closed to all user groups for the last 15 years. Recovery of the king crab resource is unlikely in the near future, and the department has requested a regulatory closure of king crab fishing for all user groups.

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Table 1. Tanner crab commercial harvest by districts from the Cook Inlet Management Area, 1968-1998.

Season ^{a/}	Southern			Kamishak/Barren Islands			Outer/Eastern			Central		
	Vessels	Harvest		Vessels	Harvest		Vessels	Harvest		Vessels	Harvest	
		Biomass (lb)	Abundance		Biomass (lb)	Abundance		Biomass (lb)	Abundance		Biomass (lb)	Abundance
1968-69		1,388,282	540,655		12,398	5,544		816	374			
1969-70		1,147,154	446,750		71,196	31,839		104,191	47,794			
1970-71		1,046,803	407,669		541,212	242,028		3,000	1,376			
1971-72		2,462,956	959,178		974,962	436,000		804,765	369,158			
1972-73		2,935,662	1,143,269		3,361,023	1,503,037		1,266,023	580,744			
1973-74		1,387,535	540,364		4,689,251	2,097,016		1,891,021	867,441			
1974-75		967,762	339,566		2,150,462	961,679		656,660	301,220			
1975-76		1,339,245	505,375	17	3,281,084	1,467,289		850,964	390,350			
1976-77	35	2,009,633	720,299	24	1,765,926	789,716		824,520	378,220			
1977-78	55	2,806,568	1,059,082	28	2,077,092	883,869		502,049	230,298			
1978-79	75	2,323,420	880,083	27	2,713,339	1,205,928		694,728	318,683			
1979-80	68	1,134,940	436,515	24	3,338,623	1,497,140		595,645	273,232			
1980-81	46	1,047,630	380,956	20	1,757,331	798,787		463,201	212,478			
1981-82	41	548,529	219,412	18	1,286,332	561,717	9	524,897	240,778			
1982-83	48	584,908	236,805	20	1,693,794	739,648	20	682,919	313,266			
1983-84	45	996,763	397,117	17	1,373,674	615,997	14	443,384	203,387			
1984-85	83	1,229,298	493,694	19	1,535,547	670,545	7	259,083	118,845			
1985-86	103	1,164,261	506,200	24	1,288,711	593,876	5	177,041	81,963			
1987	87	1,077,379	466,398	21	1,111,339	491,743	13	251,174	112,634	2	7,771	3,485
1988	127	944,763	384,050	24	417,182	182,176	23	168,969	77,866	3	8,396	3,923
1989		Closed			Closed			Closed			Closed	
1990		Closed		7	422,037	198,139		Closed			Closed	
1991	68	271,379	106,007	8	266,106	127,323		Closed			Closed	
1992	110	354,868	138,081		Closed		16	53,049	24,560		Closed	
1993	136	534,003	210,237		Closed			Closed			Closed	
1994	110	284,676	110,340		Closed			Closed			Closed	
1995		Closed			Closed			Closed			Closed	
1996		Closed			Closed			Closed			Closed	
1997		Closed			Closed			Closed			Closed	
1998		Closed			Closed			Closed			Closed	
Average	77	1,249,517	484,504	20	1,642,210	731,865	13	534,195	244,984	3	8,084	3,704

^{a/} Fishing seasons overlapped two calendar years prior to 1987.

Table 2. Mean weight of Tanner crab harvested commercially in districts of the Cook Inlet Management Area, 1974-1998.

Season ^{a/}	District			
	Southern	Kamishak/ Barren Islands	Outer/Eastern	Central
	Mean Weight (lb/crab) ^{b/}			
1968-69				
1970-71				
1971-72				
1972-73				
1973-74				
1974-75	2.85			
1975-76	2.65			
1976-77	2.79			
1977-78	2.65	2.35		
1978-79	2.64	2.25		
1979-80	2.60	2.23		
1980-81	2.75	2.20		
1981-82	2.50	2.29		
1982-83	2.47	2.29		
1983-84	2.51	2.23		
1984-85	2.49	2.29		
1985-86	2.30	2.17	2.16	
1987	2.31	2.26	2.23	2.23
1988	2.46	2.29	2.17	2.14
1989	Closed	Closed	Closed	Closed
1990	Closed	2.13	Closed	Closed
1991	2.56	2.09	Closed	Closed
1992	2.57	Closed	2.16	Closed
1993	2.54	Closed	Closed	Closed
1994	2.58	Closed	Closed	Closed
1995	Closed	Closed	Closed	Closed
1996	Closed	Closed	Closed	Closed
1997	Closed	Closed	Closed	Closed
1998	Closed	Closed	Closed	Closed
Average	2.57	2.24	2.18	2.19

^{a/} Fishing seasons overlapped two calendar years prior to 1987.

^{b/} No harvest occurred in the Central District prior to 1987; no data are available for other seasons and districts where values are missing.

Table 3. Stock status of legal-size male Tanner crab and commercial and personal use/sport harvests, Southern District, 1981-1998.

Year	Trawl Survey Estimate of Legal Males	Pot Survey Index of Abundance (Crab/pot)	Commercial Harvest		Personal Use and Sport Harvest	
			Weight (lb)	Abundance	Weight (lb) ^{a/}	Abundance
1981		16.9	548,529	219,412	10,800	4,320
1982		16.3	584,908	236,805	10,585	4,234
1983		22.1	996,763	397,117	7,710	3,084
1984		24.9	1,229,298	493,694	5,830	2,332
1985		35.4	1,164,261	506,200	8,755	3,502
1986		20.3	1,077,379	466,398	19,815	7,926
1987		23.8			22,470	8,988
1988		11.4	944,763	384,050	11,673	4,669
1989		11.9	Closed		-	-
1990	366,781	24.6	Closed		-	-
1991	536,723		271,379	106,007	2,855	1,142
1992	953,939		354,868	138,081	10,413	4,165
1993	524,319		534,003	210,237	23,015	9,206
1994	187,172		284,676	110,340	24,120	9,648
1995	235,319		Closed		27,340	10,936
1996	93,662		Closed		9,408	3,763
1997	154,163		Closed		8,048	3,219
1998	185,093		Closed			
Average	359,686	20.8	726,439	297,122	13,523	5,409

^{a/} Harvest weight calculated from harvest abundance using a mean estimated weight of 2.5 lb/crab.

Table 4. Pot index survey catch and subsequent harvest abundance of Tanner crab in the Southern District, 1974-1990.

Year	Pots Fished	Number of Females		Number of Males			Males per Pot ^{a/}		Subsequent Harvest
		Total	per Pot ^{a/}	Sublegal	Legal	Total	Sublegal	Legal	(No. of Males)
1974	240	785	3.3		3,889			16.2	339,566
1975	260	1,840	7.1		5,093			19.6	505,375
1976	227	1,757	7.7		5,014			22.1	720,299
1977	260	3,937	15.1		10,352			39.8	1,059,082
1978	237	2,617	11.0		8,508			35.9	880,083
1979	255	3,075	12.1	1,929	3,721	5,650	7.6	14.6	436,515
1980	219	1,455	6.6	7,995	4,525	12,520	36.5	20.7	380,956
1981	238	1,719	7.2	3,088	4,012	7,100	13.0	16.9	219,412
1982	222	2,772	12.5	3,749	3,628	7,377	16.9	16.3	236,805
1983	230	2,195	9.5	3,130	5,087	8,217	13.6	22.1	397,117
1984	234	1,911	8.2	3,333	5,838	9,171	14.2	24.9	493,694
1985	231	3,540	15.3	7,445	8,171	15,616	32.2	35.4	506,200
1986	237	2,886	12.2	4,497	4,822	9,319	19.0	20.3	466,398
1987	237	3,097	13.1	2,753	5,649	8,402	11.6	23.8	384,050
1988	228	2,333	10.2	1,303	2,591	3,894	5.7	11.4	Closed
1989	212	1,563	7.4	757	2,533	3,290	3.6	11.9	Closed
1990	68	303	4.5	486	1,676	2,162	7.1	24.6	106,007
Average			9.6				12.9	22.5	475,437

^{a/} Data not standardized for soak time.

Table 5. Estimated population abundance of male Tanner crab by shell condition and size class from Cook Inlet trawl surveys, 1990-1998.

Southern District													
Year	No. of Tows	Prerecruit-4	Prerecruit-3	Prerecruit-2		Prerecruit-1		Recruit		Postrecruit		Males	
				(new shell)	(old shell)	(new shell)	(old shell)	(new shell)	(old shell)	(new shell)	(old shell)	Legal	Total
1990	19	453,024	682,569	541,891	9,492	403,015	37,055	137,235	163,961	12,081	53,504	366,781	2,493,827
1991	20	316,529	295,026	826,589	35,265	790,463	117,838	279,543	187,509	45,587	24,084	536,723	2,918,433
1992	18	306,159	134,137	438,453	34,688	683,607	205,970	740,136	138,101	49,547	26,155	953,939	2,756,953
1993	19	599,873	89,299	120,343	12,548	215,292	109,962	280,719	185,496	41,158	16,946	524,319	1,671,636
1994	20	258,118	169,986	114,102	8,572	95,260	58,967	65,675	94,138	6,726	20,633	187,172	892,177
1995	20	372,035	356,327	449,225	17,330	386,004	37,399	157,383	62,421	6,049	9,466	235,319	1,853,639
1996	19	189,773	42,712	312,708	121,332	368,250	156,423	48,546	45,116	0	0	93,662	1,284,860
1997	23	148,607	111,729	267,005	6,655	311,678	36,110	143,170	10,525	468	0	154,163	1,035,947
1998	23	267,276	16,323	11,802	11,915	131,082	37,975	154,674	24,420	5,999	0	185,093	661,467
Average	20	323,488	210,901	342,458	28,644	376,072	88,633	223,009	101,299	18,624	16,754	359,686	1,729,882

Kamishak/Barren Islands Districts													
Year	No. of Tows	Prerecruit-4	Prerecruit-3	Prerecruit-2		Prerecruit-1		Recruit		Postrecruit		Males	
				(new shell)	(old shell)	(new shell)	(old shell)	(new shell)	(old shell)	(new shell)	(old shell)	Legal	Total
1990	28	1,831,889	332,005	535,114	429,654	257,792	2,085,775	105,461	488,244	0	0	593,705	6,065,934
1991	20	230,638	155,084	286,310	91,460	357,887	1,053,779	39,465	330,052	0	0	369,517	2,544,675
1992	28	251,834	552,348	360,846	233,671	166,434	1,236,465	19,629	193,576	0	3,968	217,173	3,018,771
1993	16	298,382	151,385	523,487	211,521	137,821	530,615	23,387	87,287	0	0	110,674	1,963,885
1994	17	200,254	852,801	1,168,971	431,525	916,511	673,005	51,582	126,964	0	3,968	182,514	4,425,581
1995	27	47,256	422,861	841,368	502,175	733,399	875,308	171,912	71,418	0	0	243,330	3,665,697
1996	20	681,961	162,180	297,593	366,916	730,491	1,561,542	88,162	315,768	0	3,967	407,897	4,208,580
1997	20	535,630	23,806	351,709	15,871	214,252	1,388,147	99,191	289,637	0	7,935	396,763	2,926,178
1998	23	331,580	35,709	0	67,450	31,741	319,968	31,741	87,288	0	0	119,029	905,477
Average	22	489,936	298,687	485,044	261,138	394,036	1,080,512	70,059	221,137	0	2,204	293,400	3,302,753

Cook Inlet Tanner Crab Size Classes

Class	Pre-4	Pre-3	Pre-2	Pre-1	Recruit	Post-recruit
(mm)	<70	70-90	91-114	115-139	140-165	>165

Table 6. Female Tanner crab population estimates from Cook Inlet trawl surveys, 1990-1998.

Year	Stations Sampled	Southern District Crab Abundance		Total	%Mature
		Juvenile	Mature		
1990	19	919,907	393,506	1,313,413	30.0%
1991	20	519,521	914,322	1,433,843	63.8%
1992	18	350,782	533,748	884,530	60.3%
1993	19	573,958	600,634	1,174,592	51.1%
1994	20	515,136	373,041	888,177	42.0%
1995	20	609,577	676,352	1,285,929	52.6%
1996	19	223,189	451,068	674,257	66.9%
1997	23	162,867	287,443	450,310	63.8%
1998	23	317,679	70,650	388,329	18.2%
Average		465,846	477,863	943,709	50.6%

Year	Stations Sampled	Kamishak and Barren Islands Districts Crab Abundance		Total	%Mature
		Juvenile	Mature		
1990	28	2,140,458	499,961	2,640,419	18.9%
1991	20	326,075	87,484	413,559	21.2%
1992	28	453,343	217,801	671,144	32.5%
1993	16	389,426	826,705	1,216,131	68.0%
1994	17	490,030	944,491	1,434,521	65.8%
1995	27	195,451	479,970	675,421	71.1%
1996	20	637,737	150,670	788,407	19.1%
1997	20	230,122	79,353	309,475	25.6%
1998	23	296,722	7,935	304,657	2.6%
Average		573,263	366,041	939,304	39.0%

Table 7. Pot index survey catch and subsequent harvest abundance of Tanner crab in the Kamishak and Barren Islands Districts, 1975-1990.

Year	Pots Fished	Number of Females		Number of Males			Males per Pot ^{a/}		Subsequent Harvest
		Total	per Pot ^{a/}	Sublegal	Legal	Total	Sublegal	Legal	(No. of Males)
1975	96				2,666			27.8	961,679
1976	159				1,537			9.7	1,467,289
1977	199	1,867	9.4	7,553	1,547	9,100	38.0	7.8	789,716
1978	224	1,672	7.5	13,926	3,309	17,235	62.2	14.8	883,869
1979	261	2,004	7.7	7,826	3,044	10,870	30.0	11.7	1,205,928
1980	171	711	4.2	6,187	1,470	7,657	36.2	8.6	1,497,140
1981	173	871	5.0	5,738	857	6,595	33.2	5.0	798,787
1982	70	37	0.5	1,098	238	1,336	15.7	3.4	561,717
1983	192	358	1.9	3,160	359	3,519	16.5	1.9	739,648
1984	185	196	1.1	2,429	771	3,200	13.1	4.2	615,997
1985	182	574	3.2	3,662	781	4,443	20.1	4.3	670,545
1986	184	1,226	6.7	6,709	1,290	7,999	36.5	7.0	593,876
1987	108	691	6.4	3,372	210	3,582	31.2	1.9	491,743
1988	168	664	4.0	5,419	766	6,185	32.3	4.6	182,176
1989	126	607	4.8	4,923	1,001	5,924	39.1	7.9	Closed
1990	99	334	3.4	2,630	782	3,412	26.6	7.9	198,139
Average			4.7				30.7	8.0	897,547

^{a/} Data not standardized for soak time.

Table 8. Commercial harvest of king crab by fishing season and district from the Cook Inlet Management Area, 1960-1998.

Year	District			Total Catch
	Southern	Kamishak and Barren Islands	Outer and Eastern	
Harvest (lb)				
1960-61	2,699,680	986,551	118,067	3,804,298
1961-62	1,619,642	3,642,500	368,909	5,631,051
1962-63	2,769,343	5,509,708	343,505	8,622,556
1963-64	1,960,426	4,915,303	59,352	6,935,081
1964-65	1,892,479	1,850,572	963	3,744,014
1965-66	1,948,012	1,684,346	14,491	3,646,849
1966-67	1,347,904	1,386,008	89,510	2,823,422
1967-68	1,117,394	1,883,605	239,518	3,240,517
1968-69	750,906	1,711,296	87,302	2,549,504
1969-70	1,464,721	1,688,803	73,644	3,227,168
1970-71	1,540,018	2,115,991	9,468	3,665,477
1971-72	1,992,224	2,868,315	12,657	4,873,196
1972-73	1,391,024	2,756,023	1,966	4,149,013
1973-74	1,971,841	2,236,131	5,613	4,213,585
1974-75	1,816,512	2,965,310	2,035	4,783,857
1975-76	1,674,872	1,832,484	45,293	3,552,649
1976-77	1,035,316	3,103,895	16,384	4,155,595
1977-78	584,090	1,099,279	1,350	1,684,719
1978-79	664,388	480,261	1,753	1,146,402
1979-80	853,584	489,365	4,871	1,347,820
1980-81	508,670	1,635,922	8,022	2,152,614
1981-82	183,899	1,371,821	4,142	1,559,862
1982-83	Closed	807,079	15,280	822,359
1983-84	Closed	188,027	4,504	192,531
1984-85	Closed	Closed	Closed	Closed
1985-86	Closed	Closed	Closed	Closed
1986-87	Closed	Closed	Closed	Closed
1987-88	Closed	Closed	Closed	Closed
1988-89	Closed	Closed	Closed	Closed
1989-90	Closed	Closed	Closed	Closed
1990-91	Closed	Closed	Closed	Closed
1991-92	Closed	Closed	Closed	Closed
1992-93	Closed	Closed	Closed	Closed
1993-94	Closed	Closed	Closed	Closed
1994-95	Closed	Closed	Closed	Closed
1995-96	Closed	Closed	Closed	Closed
1996-97	Closed	Closed	Closed	Closed
1997-98	Closed	Closed	Closed	Closed
1998-99	Closed	Closed	Closed	Closed
Average	1,444,861	2,050,358	63,692	3,438,506

Table 9. Pot index survey catch and subsequent harvest abundance of king crab in the Southern District, 1974-1990.

Year	Pots Fished	Number of Females		Number of Males			Males per Pot ^{a/}		Subsequent Harvest
		Total	per Pot ^{a/}	Sublegal	Legal	Total	Sublegal	Legal	(No. of Males)
1974	240			494	275	769	2.1	1.1	242,202
1975	260	432	1.7	552	573	1,125	2.1	2.2	201,759
1976	227	981	4.3	977	225	1,202	4.3	1.0	126,258
1977	260	12,075	46.4	9,772	281	10,053	37.6	1.1	82,266
1978	237	2,944	12.4	5,501	807	6,308	23.2	3.4	100,665
1979	255	2,555	10.0	2,853	665	3,518	11.2	2.6	125,527
1980	367	14,855	40.5	10,041	1,941	11,982	27.4	5.3	74,804
1981	238	2,711	11.4	2,130	519	2,649	8.9	2.2	25,901
1982	222	1,889	8.5	608	95	703	2.7	0.4	Closed
1983	230	696	3.0	447	123	570	1.9	0.5	Closed
1984	234	2,100	9.0	777	418	1,195	3.3	1.8	Closed
1985	231	941	4.1	337	273	610	1.5	1.2	Closed
1986	237	480	2.0	365	210	575	1.5	0.9	Closed
1987	237	137	0.6	188	252	440	0.8	1.1	Closed
1988	228	294	1.3	336	184	520	1.5	0.8	Closed
1989	212	62	0.3	78	105	183	0.4	0.5	Closed
1990	68	10	0.1	19	329	348	0.3	4.8	Closed
Average			9.7				7.7	1.8	122,423

^{a/} Data not standardized for soak time.

Table 10. King crab catches from Cook Inlet trawl surveys, 1990-1998.

Year	Number Of Tows	Southern District					
		Female Crab per Survey			Male Crab per Survey		
		Juvenile	Mature	Total	Sublegal	Legal	Total
1990	19	2	0	2	1	3	4
1991	20	0	8	8	1	104	105
1992	18	1	80	81	4	44	48
1993	19	3	18	21	7	8	15
1994	20	6	4	10	4	7	11
1995	20	0	1	1	0	3	3
1996	19	0	2	2	1	3	4
1997	23	0	39	39	1	8	9
1998	23	0	0	0	1	12	14
Average	20.1	1.3	16.9	18.2	2.2	21.1	23.8

Year	Number Of Tows	Kamishak and Barren Islands Districts					
		Female Crab per Survey			Male Crab per Survey		
		Juvenile	Mature	Total	Sublegal	Legal	Total
1990	28	0	4	4	2	4	6
1991	20	0	0	0	0	7	7
1992	28	1	3	4	4	22	26
1993	16	0	0	0	1	1	2
1994	17	0	0	0	0	3	3
1995	27	4	0	4	3	3	6
1996	20	2	7	9	29	2	31
1997	20	60	7	67	33	13	46
1998	23	0	5	0	14	0	14
Average	22.1	7.4	2.9	9.8	9.6	6.1	15.7

Table 11. Pot index survey catch and subsequent harvest abundance of king crab in the Kamishak and Barren Islands, 1975-1990.

Year	Pots Fished	Number of Females		Number of Males			Males per Pot ^{a/}		Subsequent Harvest
		Total	per Pot ^{a/}	Sublegal	Legal	Total	Sublegal	Legal	(No. of Males)
1975	96			1,529	2,593	4,122	15.9	27.0	201,759
1976	159			1,301	768	2,069	8.2	4.8	126,258
1977	199	7,488	37.6	4,326	698	5,024	21.7	3.5	82,266
1978	224	8,164	36.4	7,774	883	8,657	34.7	3.9	100,665
1979	261	6,123	23.5	7,553	1,109	8,662	28.9	4.2	125,527
1980	171	920	5.4	1,098	602	1,700	6.4	3.5	74,804
1981	173	1,337	7.7	1,191	1,202	2,393	6.9	6.9	25,901
1982	70	357	5.1	504	296	800	7.2	4.2	Closed
1983	192	407	2.1	250	150	400	1.3	0.8	Closed
1984	185	315	1.7	206	73	279	1.1	0.4	Closed
1985	182	247	1.4	100	314	414	0.5	1.7	Closed
1986	184	565	3.1	444	51	495	2.4	0.3	Closed
1987	108	1,169	10.8	1,374	429	1,803	12.7	4.0	Closed
1988	168	172	1.0	226	259	485	1.3	1.5	Closed
1989	126	436	3.5	330	487	817	2.6	3.9	Closed
1990	99	135	1.4	118	356	474	1.2	3.6	Closed
Average			10.0				9.2	4.6	105,311

^{a/} Data not standardized for soak time.

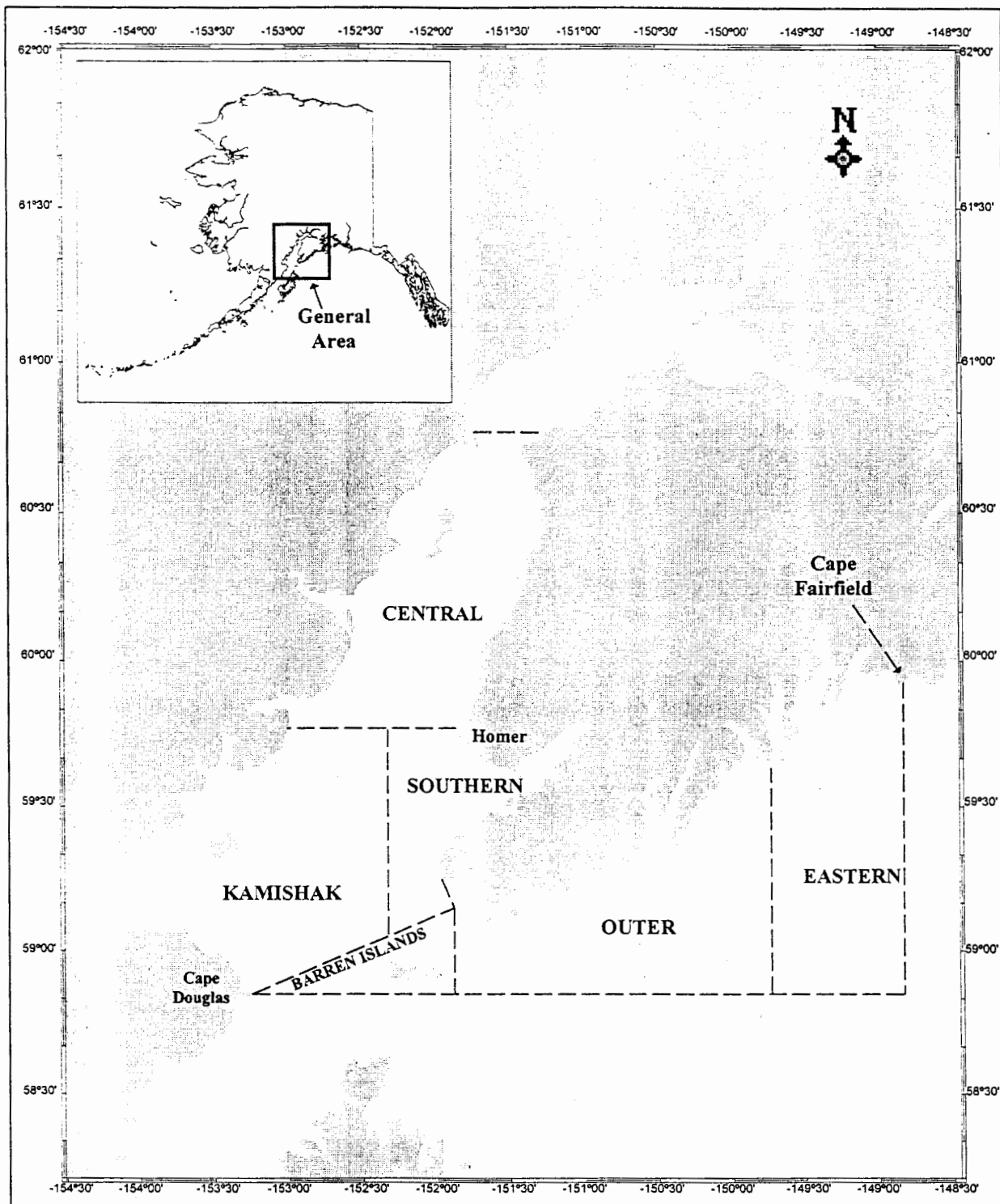


Figure 1. Commercial shellfish fishing districts of the Cook Inlet Management Area.

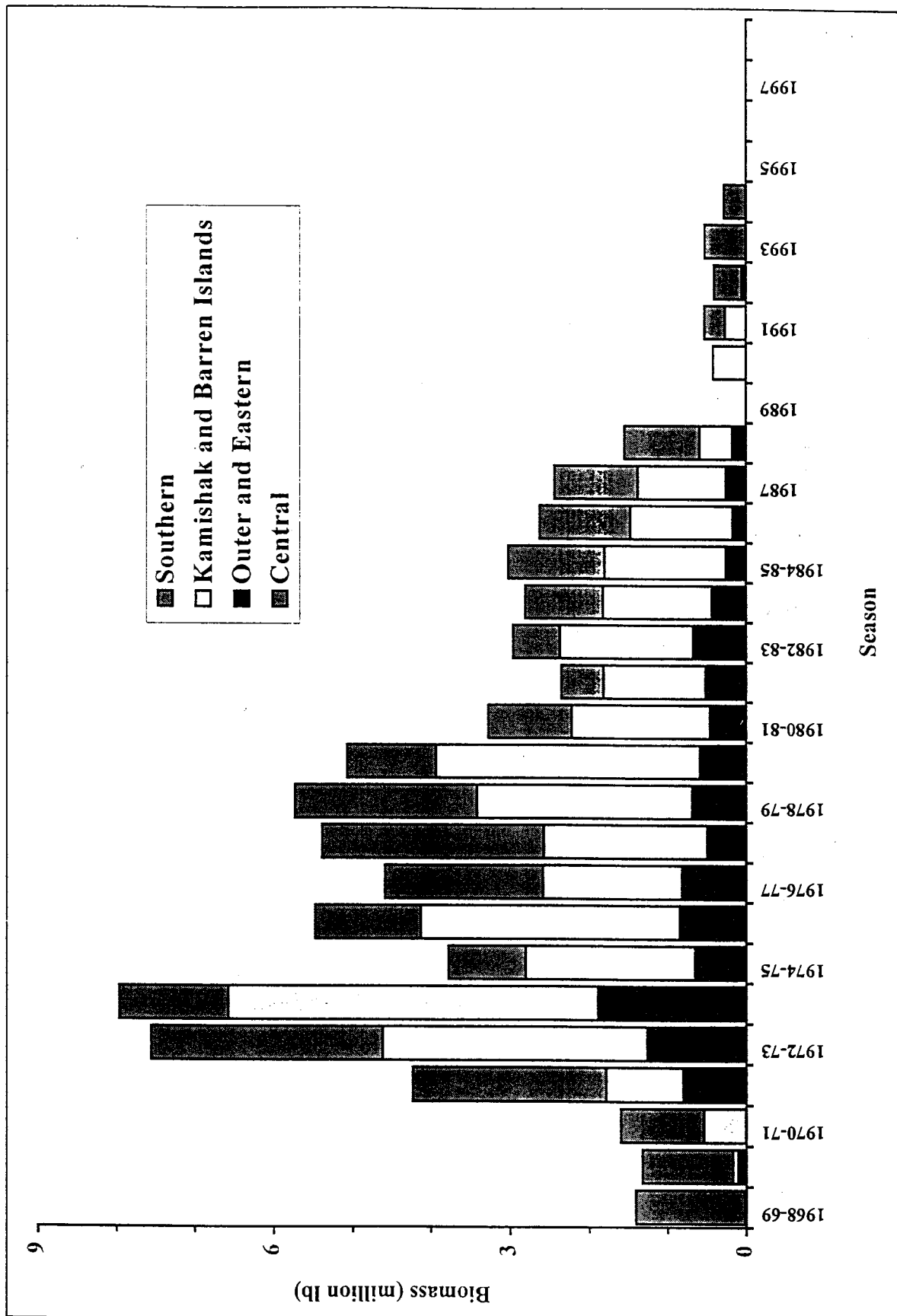


Figure 2. Commercial Tanner crab harvests by district, Cook Inlet Management Area, 1974-1998.

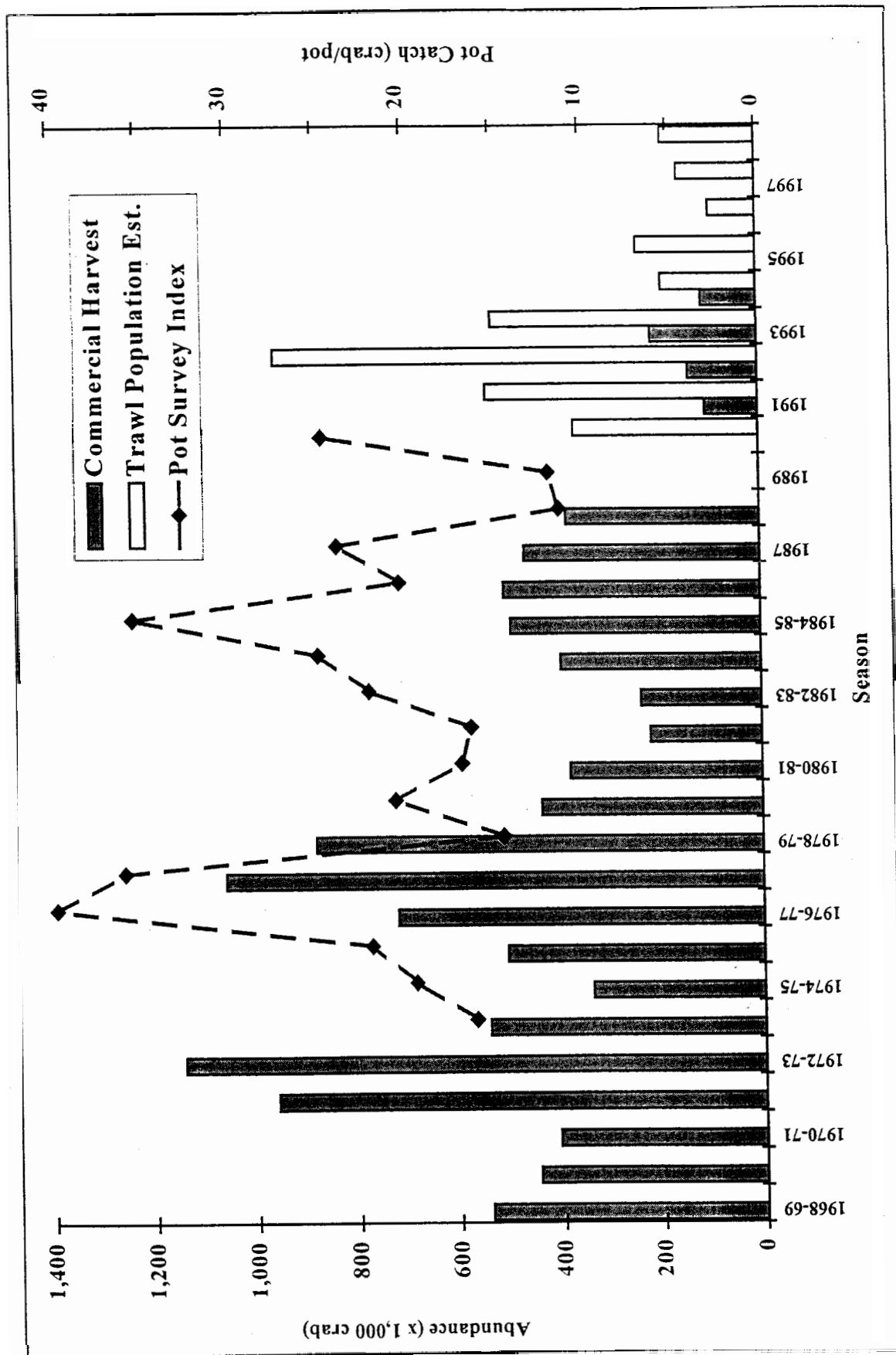


Figure 3. Harvest abundance and trawl survey and pot survey estimates of legal males Tanner crab in the Southern District, 1968-1998.

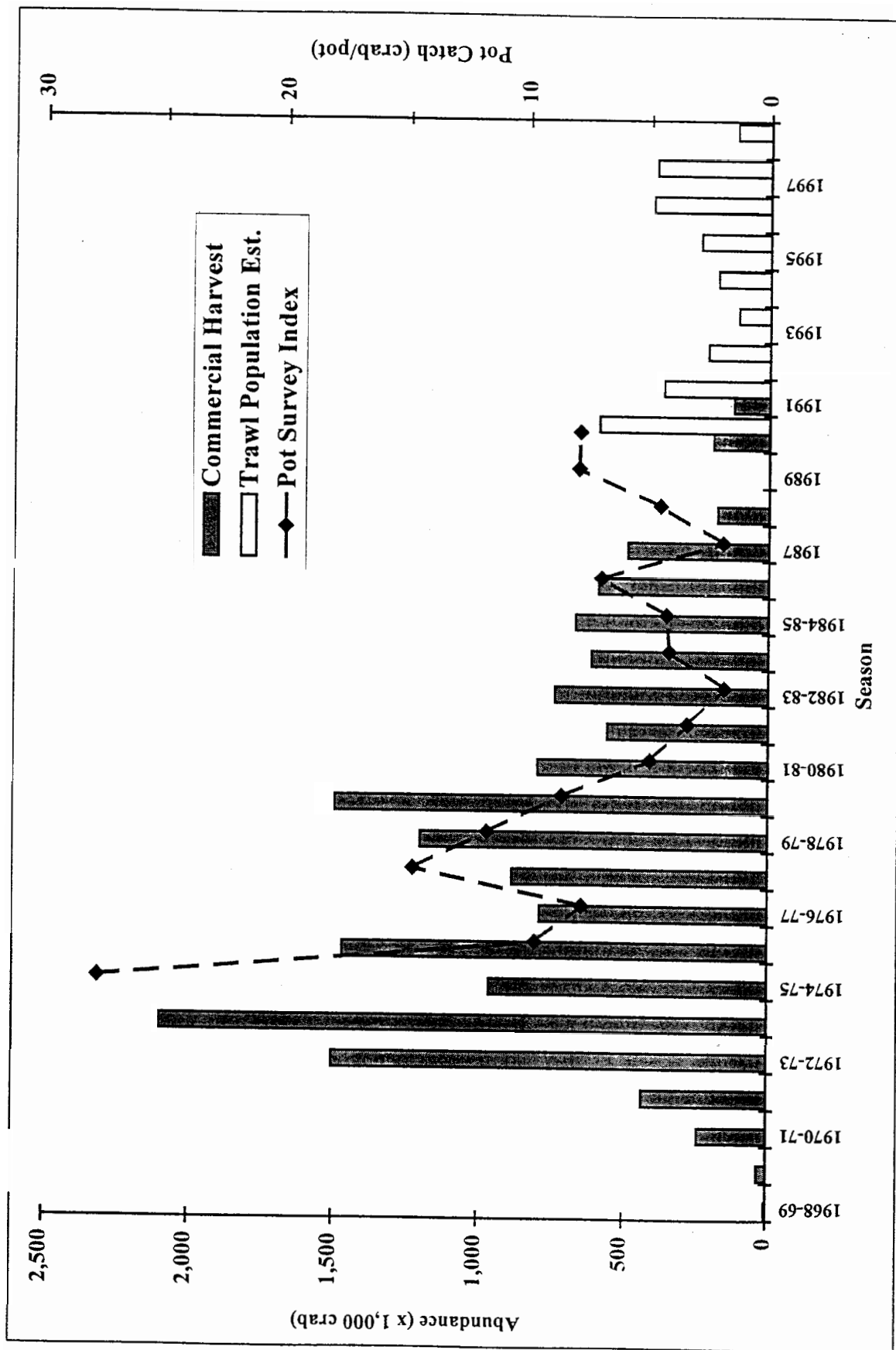


Figure 4. Harvest abundance and trawl survey and pot survey estimates of legal male Tanner crab in the Kamishak and Barren Islands Districts, 1968-1998.

Appendix A. Proposed changes to Cook Inlet Tanner and king crab regulations submitted for the 1998-1999 meeting cycle of the Alaska Board of Fisheries.

Proposal 344 - This department proposal will develop a management strategy for the Cook Inlet Tanner crab fishery by identifying the parameters under which a fishery would occur. Regulation 5AAC 35.080 requires the establishment of a Tanner crab harvest strategy. This has not been done for the Cook Inlet Management Area. In addition to the current regulatory structure, parameters include a minimum stock size threshold for opening a fishery, and a harvest rate that is stepped relative to stock size.

Proposal 345 - This department proposal would close the commercial, sport and personal use king crab fisheries. Regulation 5AAC 34.080 requires that the department develop a harvest strategy for adoption by the Board prior to any commercial king crab fishery. No king crab harvest strategy has been developed for Cook Inlet king crab. This proposal recognizes both the regulatory mandate for a harvest strategy and, given the current stock status, the low probability of a fishery in the near term. In the future, the department plans to develop a harvest strategy for review and approval by the board.

Proposal 346 - This public proposal would do several things. First, it would set a 12-pot limit for commercial Tanner and king crab fisheries in the Cook Inlet Area. Second, it restricts participation to either the commercial king and Tanner crab fisheries OR the commercial Pacific cod fishery with an allowance of five groundfish pots for crab fishermen to collect bait. Finally, it sets season dates as follows:

- 1) Kachemak Bay Tanner crab open from January 1 to March 31.
- 2) Lower Cook Inlet Tanner crab open from April 1 to May 30.
- 3) Kachemak Bay king crab open from February 1 to 15.

Proposal 347 - This public proposal would open the king and Tanner crab fisheries in the Cook Inlet Area to vessels qualified for the Federal moratorium. Qualified vessels would be limited to a maximum of 12 crab pots.

Proposal 348 - This public proposal requests the department to work with industry to conduct a pot survey just prior to the scheduled opening date of the commercial Tanner crab fishery in the Kamishak District.

Appendix B. Draft Tanner crab management plan for the Southern District.

Tanner Crab Commercial Fishing Management Plan
Southern District, Cook Inlet

Sustained Yield Stock Size

B_{MSY} = Long-term average of estimated legal male abundance during 1968-1998
= 2.7 million lb of legal male crab, or an abundance of 1.1 million legal males;

Minimum Stock Size Threshold (MSST)

= $\frac{1}{2} B_{MSY}$ = 1.4 million lb legal male crab, or an abundance of 0.5 million legal males

Guideline Harvest Rate

= 20% of Legal Males when Legal Male biomass $\geq B_{MSY}$
= 10% of Legal Males when $MSST < \text{Legal Males} < B_{MSY}$
= 0% (No Fishery) when 90% of Legal Males $< MSST$
(the latter provision prevents the fishery from driving the population below MSST)

Fishery Management

1. Existing regulations will still be implemented.
2. Prefishery Registration – Modify 5 AAC 35.405 to specify Jan 10 as a registration deadline.
3. The fishery will not open if the number of registered pots (effort) times anticipated time-specific effort (based on mean CPUE) is anticipated to yield a harvest that will substantially exceed the guideline harvest level in a 12-hour fishery opening.

Appendix C. Draft Tanner crab management plan for the Kamishak and Barren Islands Districts.

Tanner Crab Commercial Fishing Management Plan
Kamishak and Barren Island Districts, Cook Inlet

B_{MSY} = Long-term average of estimated legal male abundance during 1970-1998
= 3.5 million lb of legal male crab; or 1.6 million legal male crab

Minimum Stock Size Threshold (MSST) = $\frac{1}{2} B_{MSY}$
= 1.7 million lb legal male crab, or 800,000 legal male crab

Guideline Harvest Rate

- = 20% of Legal Males when Legal Male biomass $\geq B_{MSY}$
- = 10% of Legal Males when $MSST < \text{Legal Males} < B_{MSY}$
- = 0% (No Fishery) when 90% of Legal Males $< MSST$
(the latter provision prevents the fishery from driving the population below MSST)

Fishery Management

1. Existing regulations will still be implemented.
2. Prefishery Registration – Modify 5 AAC 35.405 to specify Jan 10 as a registration deadline.
3. The fishery will not open if the number of registered pots (effort) times anticipated time-specific effort (based on mean CPUE) is anticipated to yield a harvest that will substantially exceed the guideline harvest level in a 24-hour fishery opening.

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